Circular No. 790

# Preserving Cotton Fabrics in Outdoor Use



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## PREFACE

The usefulness of cotton cloth on the farm would be increased if it remained serviceable longer. In addition to the mechanical damage expected from ordinary use, cotton goods become weakened if exposed continuously to the weather. Sunlight and mildew are the chief causes of this deterioration.

The cloth can be protected from the harmful effects of sunlight by treatment with mineral pigments or other materials that have the power of absorbing certain light waves. The danger of mildew can be reduced by treating the cloth with compounds that lower its capacity to absorb moisture, or, occasionally, by adding substances that are poisonous to micro-organisms.

This circular gives information about the properties, selection, and care of cotton duck and lighter fabrics for farm use and describes the preparation and application of several treatments that have been found to give effective protection to such fabrics when they are exposed to weather.

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# Preserving Cotton Fabrics in Outdoor Use

By James D. Dean, *principal chemist, Cotton Chemical Finishing Division, Southern Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration* [1]

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## USES OF COTTON FABRICS

Woven cotton fabrics ranging from heavy duck to light shade cloth find many uses on the farm or ranch, although probably their chief function is to protect farm equipment and products from rain, sun, and dust. Coverings for machines, trucks, automobiles, sacked grain, and stacks, covers for horses, shade for young plants and seedlings, use in tents and awnings are some of the farm duties performed by cotton goods. No doubt they would be used to a greater extent if they fulfilled more effectively these various purposes and if they retained their serviceability longer.

This circular tells how to select and care for cotton duck and lighter fabrics on the farm, and describes simple methods for prolonging their serviceability by the application of waterproofing and weatherproofing treatments. It should be noted that the protective finishes recommended are designed primarily for use on shelter and cover cloths. They are not suitable for garment fabrics or for grain and vegetable containers.

## CLASSES OF COTTON DUCK

"Duck" is a term used in this country to denote a range of firm, heavy cotton fabrics, all of plain weave. The name is said to owe its origin to the stenciled figure of a duck that identified the heavy-

[1] This circular supersedes Farmers' Bulletin 1157.

weight flax or hemp sailcloths once imported from England. Canvas, a name often used interchangeably with duck, apparently is from an old French word, "canevas," which was applied to heavy hemp or flax fabrics. A common name for treated heavy cloths of this kind, "tarpaulin," originated in an old navy custom of painting a canvas hatch cover—sometimes called a pall or palling—with tar to make it waterproof.

In common with all other woven fabrics, cotton ducks are made by interlacing filling yarns, which run across the piece from selvage to selvage, with warp yarns running the long way of the goods. The character of the cloth is determined by the kind of yarns used and by the number of warp and filling yarns woven per inch. The yarns may be single or they may be plied, which means two or more single threads are twisted together. The "count" of the cloth is the number of warp and filling threads to an inch—for example, a duck counting 44×34 means the material has 44 warp threads and 34 filling threads to the square inch.

Cotton duck is manufactured in a great variety of widths, weights, and counts. It is probably sufficient here to consider only the three general classes most commonly used on the farm or ranch. These are numbered duck, army duck, and flat duck. Army duck and flat duck are both usually known as "ounce" ducks, because they are identified by their weights in ounces per yard rather than by numbers; but because of their different constructions it is simpler to describe them separately.

The weight of the cloth in ounces per yard is most commonly used in distinguishing duck of one construction from another in the same class. Since duck of each class is manufactured in several widths, it is apparent that the width of a given fabric must always be known if its weight per linear yard is to have a definite meaning. It has therefore been a trade custom to employ a certain fixed width for each class of duck as the basis upon which weight per linear yard is computed. Of the three classes here described, the weights of numbered duck in ounces per yard are based on a width of 22 inches, those of army duck on a width of 28½ inches, and those of flat duck on a width of 29 inches.

To avoid confusion, there has been a movement in the trade to adopt a uniform classification of duck in which all fabric weights are given in ounces per square yard of gray goods (cloth as it leaves the loom), regardless of the widths in which they are woven. Tables given at the end of this circular show the weights of cotton duck both in ounces per square yard and in ounces per linear yard. In cases where the weight per linear yard is employed in the text, the letters "m. d." (mill designation) are inserted.

The chief construction features of the three general classes of duck are shown in figures 1 to 3, inclusive. In each figure, *A* is a normal-size photograph of the fabric, *B* is a magnified photograph,[2] and *C* is a drawing (not drawn to scale) showing details of the yarn plies and weave. The army and flat ducks illustrated are relatively light fabrics, weighing 10 to 13 ounces per square yard; the numbered-duck sample is a heavy fabric, weighing 24.5 ounces per square yard.

[2] Magnified 4 times.

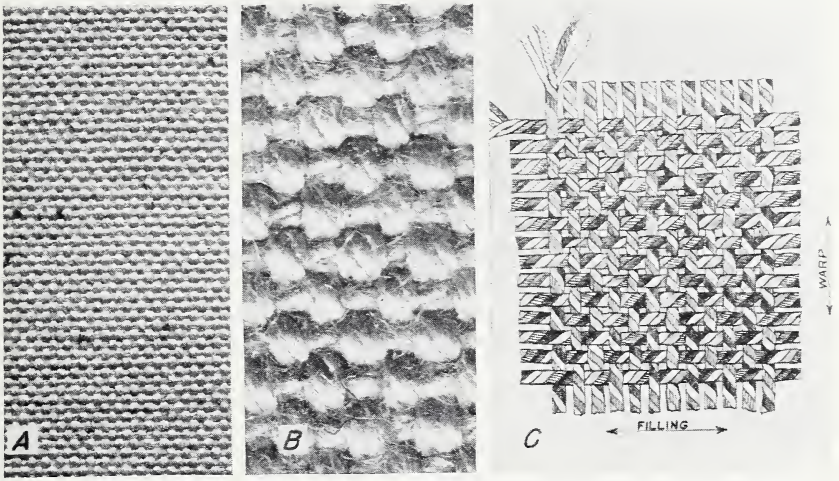


FIGURE 1.—No. 4 duck, 24.5 ounces to the square yard: *A*, Natural size; *B*, magnified; *C*, details of construction.

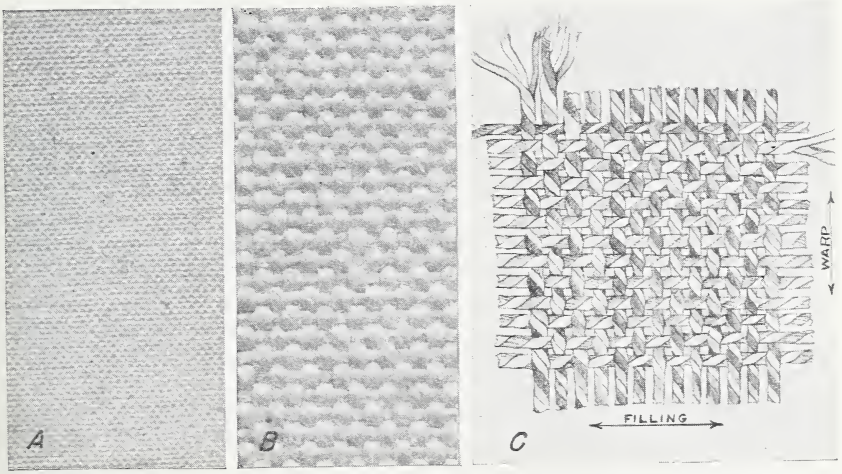


FIGURE 2.—Army duck. 12.6 ounces to the square yard; *A*, Natural size; *B*, magnified; *C*, details of construction.

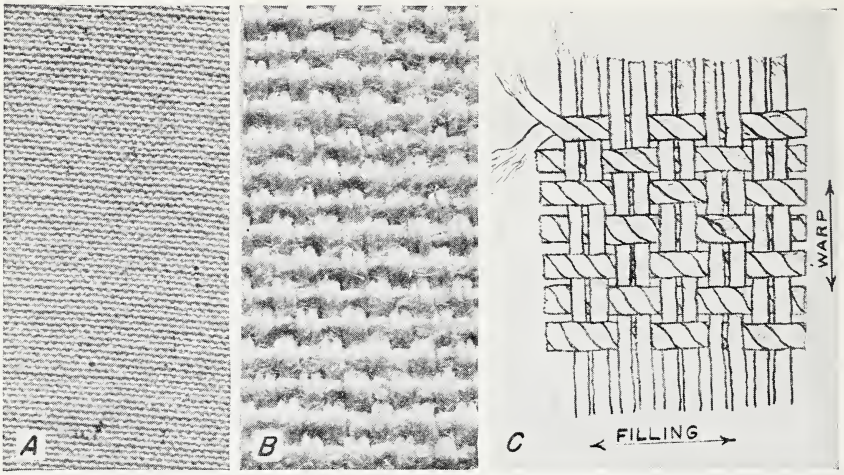


FIGURE 3.—Double-filled flat duck, 10 ounces to the square yard: *A*, Natural size; *B*, magnified; *C*, details of construction.

NUMBERED DUCK.—Duck of this class is made of multiple-ply yarns in both warp and filling (fig. 1). The numbers run from 1 to 12, with weights decreasing so that No. 1 is the heaviest and No. 12 the lightest in the series. Heavier ducks are in the "naught" series, with numbers written 1/0, 2/0, etc. The order of weights is reversed in this series, 1/0 being the lightest and 12/0 the heaviest.

Numbered duck is manufactured in many widths—from 22 up to 144 inches. It is also made in three different grades, known as soft, medium, and hard texture. Of these three, soft-texture duck is little used. Hard-texture duck differs from medium-texture in being woven with a few more threads to the inch, either in warp or filling or both, and in having a somewhat higher breaking strength.

As previously stated, the weights of numbered duck are based on a fabric 22 inches in width. On this scale, starting with No. 12, which weighs 7 ounces per yard, the weights increase 1 ounce per yard with each number, up to 12/0, which weighs 30 ounces per yard. Table 1 (p. 16) shows the weights of numbered ducks both by the system of ounces per linear yard of cloth 22 inches wide and by the system of ounces per square yard, as well as the plies of the yarns used in different weights.

ARMY DUCK.—This is the best grade of light and medium-weight duck on the market. Like the numbered duck, it is made of multiple-ply yarns both in the warp and filling directions (fig. 2) but as compared in the most nearly equivalent weights, the army duck is woven with more filling threads to the inch, and the closer structure thus secured improves its resistance to water penetration. Weights of army duck are based on a width of 28½ inches. These are given in table 2 (p. 17), in comparison with the weights in ounces per square yard.

FLAT DUCK.—The construction of this fabric is characterized by the use of single-ply warp yarns. The filling yarns are considerably thicker than the warp yarns, and because of this the latter are woven in pairs, but not twisted together, to make a fabric of more uniform appearance. In double-filled duck (fig. 3) plied filling yarns are used,

and the cloth structure is somewhat closer than in the single-filled type which has unplied yarns in both warp and filling. The single-ply warp yarns used in these flat ducks are sized—treated with a mixture of starch and tallow softener—to facilitate weaving. Such treatment is not required when plied warps are used. Flat duck therefore owes part of its weight to the sizing mixture, which is soon lost when the material is exposed to weather. This mixture may increase both water absorption and susceptibility to mildew.

Because of its more open structure, flat duck has less natural resistance to water and cannot be as effectively waterproofed as the plied-yarn ducks. For this reason it cannot be generally recommended for outdoor use. On the other hand, it is often more readily available, and in cases where water resistance is not of great importance may be found to give very satisfactory service. Weights of the flat duck are based on a 29-inch width. Table 3 (p. 17) compares these with weights per square yard.

## SELECTING COTTON DUCK FOR FARM USE

It is usually more economical to buy a good grade of duck, even at a decidedly higher first cost, than a cheap duck which is poorly constructed and will not prove serviceable.

For most farm purposes only unbleached, unsized, closely woven duck should be used. It should not be too stiff, however, nor so closely woven that it has no flexibility when wet and cold, for otherwise it has a tendency to crack when creased or folded. Furthermore stiff canvas is very difficult to handle, and, when used as a cover, does not shape itself properly to objects; as a result, it does not give them adequate protection. For horse covers, however, a moderately stiff canvas is preferable, as it does not lie close to the body of the animal and does not cause sweating as readily as the more flexible material.

Duck which when held up to the light shows numerous pinholes or thin places does not make good covers, although a few small pinholes may be expected. The best duck is made from multiple-ply yarn, and the weave is moderately hard. The ply of the yarns can be determined by untwisting them and counting the number of small threads into which they separate. To determine the closeness of the weave, the duck may be unraveled on two adjacent sides and the number of ends of yarn in a measured inch on each side counted.

Large Covers or Paulins.—These should be made of No. 8 duck, which weighs about 18 ounces per square yard, or 15-ounce (m. d.) army duck, weighing about 18.9 ounces per square yard.

Wagon and Machine Covers.—Either No. 10 or 12-ounce (m. d.) army duck is suitable for this purpose, as both have sufficient body without being too stiff when wet. No. 10 duck weighs about 14.7 ounces and 12-ounce (m. d.) army duck about 15.2 ounces per square yard.

Hay Caps and Other Small Covers.—No. 12 duck, weighing about 11.5 ounces per square yard, or 10-ounce (m. d.) army duck, weighing 12.6 ounces per square yard, is satisfactory for this purpose. Although not so durable, lightweight fabrics such as 7-ounce or 8-ounce (m. d.) khaki army duck, or even closely woven unbleached sheeting that has been waterproofed, can be used for hay caps.

Awnings.—Eight-ounce (m. d.) duck is sufficiently heavy for this purpose. Khaki army duck, either plain or decorated with painted stripes, is more serviceable than ordinary awning ducks.

Tents.—Ten-ounce (m. d.) army duck is suitable for medium-sized tents that are used occasionally for short periods of time. For large tents or tents that are used continuously 12-ounce (m. d.) army duck is more serviceable. Shelter-tent duck is very suitable for lightweight tents.

## LIGHTER COTTON FABRICS

In addition to heavy duck or canvas, some of the lighter cotton fabrics find frequent employment on the farm. These include osnaburg, sheetings, drills or twills, and various kinds of lightweight shade cloths. The selection of such materials is governed by the particular services required of them, although in general the stronger and more closely woven types usually prove more satisfactory.

Cotton osnaburg is a coarse, heavy sheeting of plain weave, usually made in widths of between 30 and 40 inches and weighing from 4 to 7 ounces per square yard. It is often used for grain and feed bags, and supplies of these sometimes accumulate on the farm. This cloth is not woven closely enough to make it a good base for waterproofing, but its texture may be closed somewhat by washing and then drying without tension. After drying, it may be given one of the proofing treatments described in this circular. Sometimes the treated cloth can be doubled to give better protection.

The heavier types of plain cotton sheetings, although usually somewhat lighter than osnaburg, may be treated and used in the same way for protective coverings. These commercial coarse sheetings are of moderately close weave and are made in widths ranging from 36 up to 108 inches, with weights ranging from about 3 to 6 ounces per square yard.

There is also manufactured a wide range of cotton twills or drills, many of them heavier and more closely woven than the sheetings, which may be given the same protective treatments. These fabrics are constructed in such a manner that the intersections of their warp and filling threads form diagonal wales, or ribs, in the cloth.

Tobacco cloths are light, open-weave fabrics allied to cheese cloth and surgical gauze in their construction. They are made in different widths and are sometimes cut and sewed by the manufacturers in special sizes to meet their customers' requirements.

Representative samples of unbleached osnaburg, plain sheetings, drill, and tobacco cloth are illustrated in figures 4, 5, 6, 7, and 8, in which the magnified photographs reveal the relatively open construction of these lighter fabrics as contrasted with the closely woven ducks shown in figures 1 and 2. Details of their thread counts, widths, and weights are given in table 4 (p. 17).

## CARE OF COTTON FABRICS

The deterioration of cotton cloth is due to a number of causes other than use. One is mildew, which usually appears when the cloth remains damp for several days in warm weather. Mildew is usually recognized by the appearance of colored spots—black, brown, green,

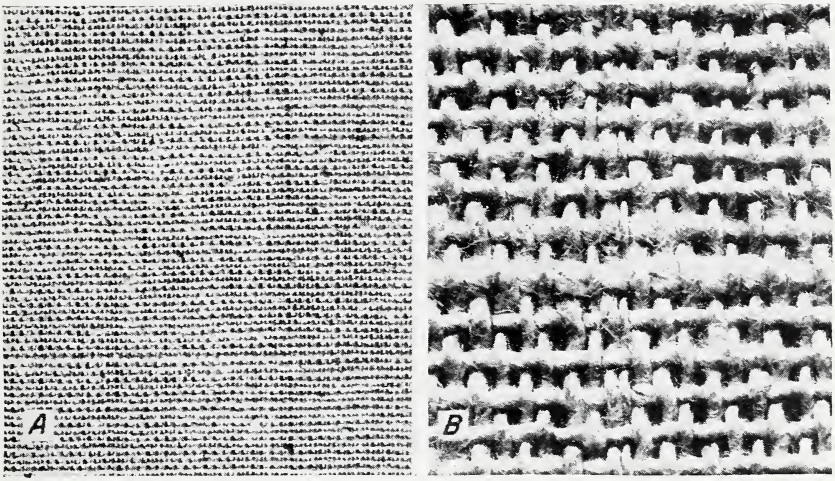


FIGURE 4.—Osnaburg, 7.0 ounces to the square yard: *A*, natural size; *B*, magnified.

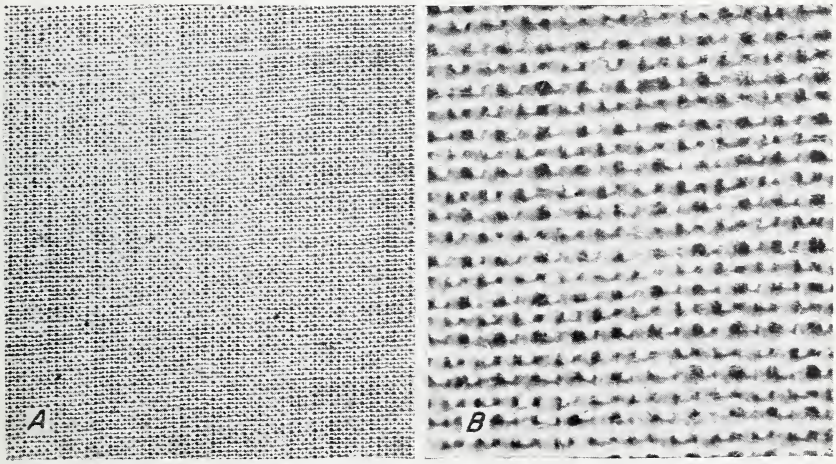


FIGURE 5.—Coarse sheeting, 5.6 ounces to the square yard: *A*, natural size; *B*, magnified.

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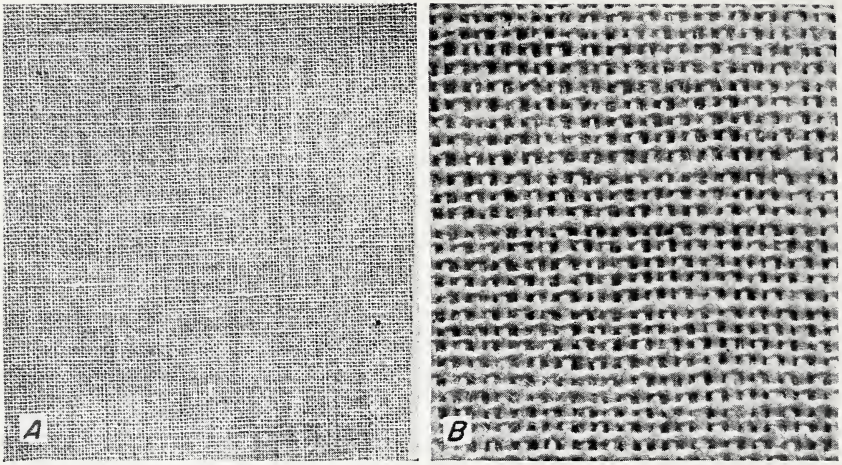


FIGURE 6.—Fine sheeting, 4.0 ounces to the square yard: *A*, natural size; *B*, magnified.

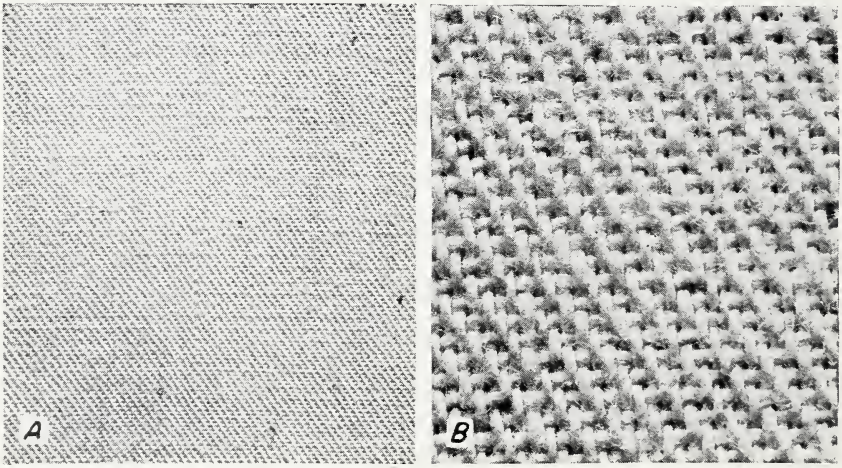


FIGURE 7.—Drill, 7.5 ounces to the square yard: *A*, natural size; *B*, magnified.

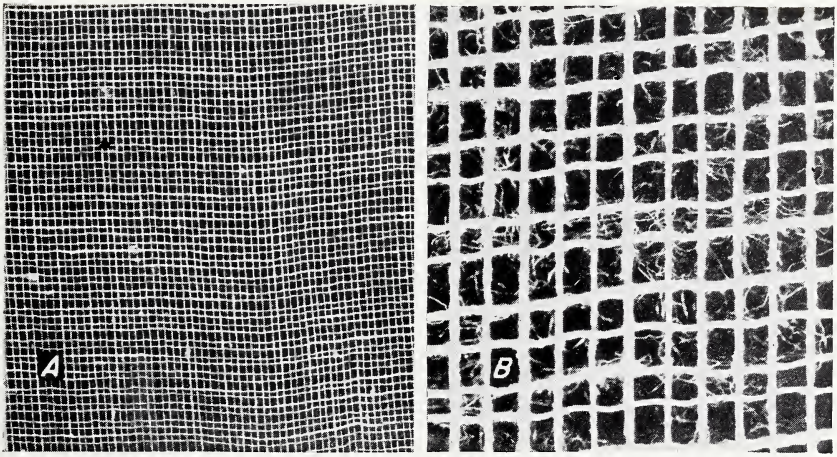


FIGURE 8.—Tobacco cloth, 1.1 ounces to the square yard: *A*, natural size; *B*, magnified.

pink, etc.—ranging in size from that of a pinhead to that of a 25-cent piece. Cloth may be injured also by bacterial action, which produces no marked change in the color but weakens the entire fabric. This occurs when it has lain for some time in contact with the ground or a damp floor. In addition cloth may be weakened by the chemical action of materials in it or simply by exposure to sunlight.

Untreated cotton cloth mildews very quickly under certain conditions such as warmth, absence of light, and a moist atmosphere. If the cloth is folded and stored wet, or even slightly damp, it usually becomes more or less mildewed, especially if it has been put in a rather warm, dark place. Such cloth is much weakened and leaks in the mildewed places; so that if not totally useless when first taken out, it soon becomes so in service and must be replaced.

Cotton cloth should be thoroughly dry before it is folded or stored away, or even permitted to lie undisturbed for more than a few days. Drying is best done by hanging or spreading out the cloth in open air and sunshine, although in wet weather it may have to be hung under shelter. Folding heavy duck, especially if it has been stiffened by a protective treatment or by being wet or frozen, may weaken or crack the fabric, causing it to leak. For this reason heavy duck when not in use should hang over a beam or long pole or should be suspended against the inside of a barn or shed rather than folded. Avoiding unnecessary exposure to weather will help to prolong the useful life of all cotton fabrics.

## PROTECTIVE TREATMENTS

Treatments designed to prolong the life of cotton fabrics in outdoor use should protect them against water, mildew, and sunlight. Waterproofing a fabric is often desirable as an end in itself; but a waterproofing treatment alone may not afford complete protection against mildew and may actually increase the destructive action of sunlight. Resistance to these three factors must therefore be con-

sidered in preparing an effective protective treatment. Some weatherproofing treatments increase the flammability of these fabrics and therefore add to the farm fire hazards.

Resistance to Water.—All cotton cloth as it comes from the loom, even unbleached yarn, has some water repellency due to the natural waxes of the fiber, or in some cases to the presence of a small amount of mineral oil, with which the lint is often sprayed in preparation for spinning. In the gray or loom state a heavy and closely woven fabric such as cotton duck or tent twill normally has enough natural water resistance without special treatment to be used for wagon covers, tents, and awnings, if it is not in a horizontal position and is not in contact with objects beneath it. Lighter weight gray fabrics of more open construction cannot be used successfully for such purposes because of the relatively large spaces between their threads, through which water penetrates. When the natural waxes are removed, cotton fabrics have high moisture absorption—even a closely woven duck which continues to shed rain soon becomes completely saturated with water.

Cotton cloth may be made resistant to water by treatment with any one of a number of different compounds. Among the best known of these are various mineral and vegetable oils and waxes, bituminous products such as tar and asphalt, insoluble mineral soaps, and chemical treatments that include acetate of aluminum and cuprammonium. A commercial showerproofing process once widely used was carried out by impregnating cloth with a soap solution and then passing it through a solution of aluminum acetate. The reaction precipitated in the fabric an insoluble aluminum soap which rendered it highly water repellent. Modern methods have improved on this process by combining the soap and metallic compound in a stabilized emulsion that can be applied to cloth in a single treatment. The use of vegetable oils for waterproofing cloth ("oilskins") has long been familiar, and paraffin wax often is applied for the purpose.

All such treatments render cloth resistant to water, but in many cases also make it so sensitive to the action of sunlight that they cannot be recommended for goods intended for continued outdoor use. Treatment with paraffin or petrolatum, for example, has been found to result in a loss of strength in cotton duck exposed to weather that was double the loss of strength in an untreated sample during the same exposure. Duck treated with linseed oil lost 65 percent of its original strength, as compared with a loss of only 40 percent in untreated duck. Oils and waxes of this kind are the most easily applied waterproofing treatments, but if the fabric is to undergo exposure they should be used only with some material that offsets their tendency to increase the destructive action of sunlight. These treatments also increase the flammability of the fabric.

Resistance to Mildew.—Warmth and moisture are necessary for the development of the micro-organisms that cause mildew and rotting of cotton materials. Under favorable temperature conditions, fungi can grow on cotton that contains only about 10 percent of moisture, an amount not very far above its normal moisture content. Since these organisms are found to develop freely at temperatures between 70° and 90° F., it is evident that even in cool climates mildew may often occur during summer, while in warm and moist regions such

as are found in in the Gulf Coast States it is prevalent through the greater part of the year. In temperate climates treatment of cloth with a water repellent may protect it adequately from mildew by decreasing its absorption of moisture. Where climatic conditions are very favorable to mildew, addition to the water repellent of a fungicide or substance that destroys micro-organisms has given better results.

Recently new and effective fungicides have been developed, but most of them either have to be applied in too complicated a way to be suitable for home use or are not readily obtainable. Such long-used fungicides as paris green, bordeaux mixture, and various arsenic compounds are not well adapted for fabric treatments, since they may dust off and be inhaled or contaminate foodstuffs.

A more satisfactory type of fungicide for cloth treatment is copper naphthenate, a compound now widely used to protect military tents and coverings of all kinds from micro-organisms. Although not yet very widely distributed, copper naphthenate is handled by chemical dealers and some paint stores. A product of the petroleum industry, it is usually sold as a soft, waxlike solid or very thick liquid, bluish green in color, containing from 2 to 10 percent of copper. It dissolves readily in petroleum solvents such as mineral spirits and dry-cleaning fluids. Cloth treated with small amounts of this fungicide is well protected against mildew, but more permanent results are secured if a water-resisting substance is added. These treatments also increase the flammability of the fabric.

Resistance to Sunlight.—The tendering of cotton fabrics when exposed to sunlight is caused by the destructive action of certain wave lengths in the solar spectrum. These harmful light waves are absorbed by various compounds, among which some of the best known are such coloring materials as lamp black, chrome yellow, and zinc oxide and the earth pigments, ochre, umber, and sienna.

Mineral-dyed duck is used for tents and coverings of many kinds. The cloth is dyed by precipitating in it finely divided hydroxides of iron and chromium. Duck so dyed retains more strength than undyed fabric during long exposure to sunlight, and is also usually more resistant to mildew. Unless the cloth is to be given a weatherproofing treatment, only mineral-dyed duck is recommended for heavy service. Tan or khaki shades can also be produced by organic dyes, but except for fast vat dyes, mineral dyeing is generally to be preferred.

The following test will readily distinguish between cottons mineral-dyed and organic-dyed:

Burn a few threads until no black carbon is left in the ash. If mineral dyes have been used an appreciable amount of buff or tan ash will remain; if organic dyes have been used there will remain only a trace of white or grayish ash.

## FORMULAS

That a good weather-resistant treatment for cotton fabric should protect it against water, sunlight, and mildew has been recognized in the military service. For example, regulations require that duck for use in tents and coverings receive a finish rendering it resistant to weather, fire, mildew, and water.

In formulas for home use in weatherproofing cloth the choice of materials is necessarily limited to those that can be procured in moderately small quantities with little effort and at fairly low cost.

Treatments prepared according to the following formulas have been found satisfactory for increasing the serviceability of cotton fabrics, and it is believed that they will meet the requirements of the farmer, ranchman, and others using such materials for outdoor purposes. Although intended primarily for application to duck or canvas, these formulas may also be used for lighter goods.

For portable covers requiring a fairly soft and pliable finish formulas 1, 2, and 3 are recommended:

**Formula 1**

| | | |
|---|---|---|
| Petrolatum (petroleum jelly), dark or amber | pounds | 8½ |
| Beeswax, yellow refined | pounds | 1½ |
| Earth pigment, dry (ocher, sienna, or umber) | pounds | 5 |
| Mineral spirits | gallons | 5 |

**Formula 2**

| | | |
|---|---|---|
| Petrolatum (petroleum jelly) | pounds | 8½ |
| Beeswax | pounds | 1½ |
| Earth pigment, dry | pounds | 5 |
| Copper naphthenate | pounds | [1] 1½ |
| Mineral spirits | gallons | 5 |

[1] This amount is calculated for a naphthenate containing approximately 10 percent copper. Proportionally larger amounts of less concentrated products should be used.

**Formula 3**

| | | |
|---|---|---|
| Petroleum asphalt, medium hard | pounds | 7½ |
| Petrolatum | pounds | 2½ |
| Lampblack | pounds | 1 |
| Mineral spirits | gallons | 5 |

Usually the quantities specified are sufficient to treat 50 to 75 square yards of canvas on one side.

The less readily flammable petroleum distillates such as mineral spirits or the modern dry-cleaning solvents [3] are best for making up these formulas. Cloth treated with formulas 1 and 2 will be colored buff by ocher, khaki by raw sienna, drab by raw umber, and brown by burnt umber. If a white treatment is preferred, dry white zinc oxide may be used in place of an earth pigment. If this compound is used in formula 2, the cloth will be slightly tinted by the bluish-green color of the copper naphthenate. When the brownish earth pigments are used, the color effect of the naphthenate is not noticeable. Mixing these formulas and treating cloth must be done either out of doors or in a well-ventilated place—never in an enclosed space. All lights and fires must be extinguished. Until thoroughly dry treated fabric should be hung in a well-ventilated space, preferably out of doors, where no possible source of ignition is present. Hands should be protected from contact with the liquid by neoprene gloves.

It will be seen that formula 2 is the same as formula 1 except for the addition of the copper naphthenate. The presence of this fungi-

[3] For example, Stoddard solvent, which is sold under various trade names by many oil refiners.

cide gives the cloth greater resistance to micro-organisms, and formula 2 is therefore recommended for use where severe mildew can be expected. Formula 3 serves as an alternate for formula 1, depending on the availability of materials. Copper naphthenate may be added to it in the same way.

For permanently fixed covers where a stiff finish is not objectionable formulas 4 and 5 are recommended:

**Formula 4**

| | | |
|---|---|---|
| Boiled linseed oil | gallon | 1 |
| Lampblack, ground in linseed oil | pounds | 2 |
| Japan drier | pint | 1 |

**Formula 5**

| | | |
|---|---|---|
| Boiled linseed oil | gallon | 1 |
| Aluminum bronzing powder | pound | 1 |
| Japan drier | pint | ½ |

These formulas are practically identical except for the different pigment used. Canvas is colored black by formula 4 and silver by formula 5. Tests have shown no significant difference in their protecting properties.

Petrolatum and beeswax can be purchased from druggists or from wholesale dealers in druggists' supplies. Petroleum asphalt can sometimes be supplied by dealers in roofing materials or can be ordered from refiners of asphaltic-base petroleum. Copper naphthenate, as previously noted, can be obtained from chemical or paint dealers. The other materials specified in the formulas can be obtained from paint stores.

### MIXING THE MATERIALS

In the preparation of formulas 1, 2, and 3, place the specified weights of waterproofing materials in a suitable metal container and melt slowly and carefully at as low a temperature as possible, with constant stirring.

The entire operation should be done out-of-doors or in a well-ventilated place, where there is no fire or open flame, and the melted material should be poured into the solvent while stirring.

For formula 2, the copper naphthenate is best weighed separately into a small uncovered pail or can and a portion of the solvent added for solution. It will dissolve more quickly if the container holding the naphthenate and solvent is placed in a large can or tub of hot water while the contents are stirred. This must not be done near any open flame, or the fumes from the warm solvent will ignite. After the naphthenate is dissolved, the solution can be added to the rest of the solvent before pouring in the melted waterproofing materials.

When a pigment is used, thin the pigment in a separate container by mixing with it small additions of the liquid, and when the pigment is sufficiently thinned strain it through fine-mesh wire screen or several thicknesses of cheesecloth into the waterproofing liquid. In formulas 4 and 5 the pigments should be thinned in a similar manner with linseed oil before they are added to the bulk of the oil.

When the solid materials tend to settle to the bottom of the container or to thicken, it will be necessary to warm the mixture just

before applying it to the cloth. This can be done in the open air by placing the container in a tub or can of hot water.

Be sure that the container is open, and never place it over or near a flame.

### APPLICATION

The mixture must be thoroughly stirred before and during application, in order to keep the undissolved materials in suspension. The preparations may be applied to closely woven fabrics by means of a paint brush or by spraying. Wagon covers, shock covers, etc., may be treated best by stretching the canvas against the side of a building or attaching it to a frame and applying the material with a brush. Once the cloth is fixed in position, no more time is required to treat it than is necessary to apply a first coat of paint to a rough board siding having the same area. Much time may be saved in treating large paulins and standing tents by applying the material with a spray pump with which a pressure of at least 50 pounds is developed. Some loss of material, however, results from this method. Persons applying compounds with a spray apparatus should wear a respirator equipped with filter elements for removing poisonous dusts and mists.

If it is desired to treat light, open-weave fabrics such as those sometimes used to cover beds of growing plants, formulas 1 or 2 will prove most satisfactory. Since application by brushing or spraying such fabrics may prove wasteful, the cloth may be immersed in the liquid and worked with a stick until it is thoroughly saturated. In this case the mixture should be previously thinned somewhat by adding an extra gallon of mineral spirits to the formula. The cloth is then squeezed out through a laundry wringer and hung or spread out to dry. During impregnation of the cloth in this way the hands should be protected as far as possible from contact with the liquid.

The experience of the Department of Agriculture has been that one coat applied to one side of a closely woven cloth usually is sufficient. With application in this manner, when the strength of the solution is that given in the formulas, there will be an increase in weight of approximately 40 to 50 percent with formulas 1, 2, or 3 and of about 60 to 70 percent with formulas 4 or 5.

When cloth is treated with linseed-oil preparations it should be allowed to dry thoroughly (for 2 or 3 weeks) while freely exposed to the air. If it is folded and stored in a warm place before drying is complete, the accumulated heat from continued oxidation may result in spontaneous combustion.

## NOTES ON THE EFFECTIVENESS OF DIFFERENT PROTECTIVE TREATMENTS

The first systematic attempts to protect cotton fabrics against the destructive action of weather are said to have resulted from the reports of British army officers on the rapid deterioration of tentage and covers observed during the war in South Africa at the end of the last century. This led to the development of a cupramonium treatment, which has been largely used in England but requires special plant equipment for application to cloth.

Research on protective treatments in this country was greatly stimulated by the vast military requirements for duck and canvas during

World War II. Tents, tarpaulins, and coverings of different kinds were employed in many parts of the world, often under such severe conditions of service that without adequate protection they became useless after a few weeks or months. The finish specified by the Army for tent duck and similar coverings was designed to render the cloth resistant to fire, weather, water, and mildew, and a treatment that met these requirements was developed and widely used.

The formula required for finishing army duck is too complicated for home application. Some dealers in tent and awning duck can supply canvas that has received this type of finish at the factory, or sell a canvas-protecting compound that has effects similar to those given by the Army treatment. This can be purchased in containers of convenient size and applied to cloth by brushing or spraying. There are also numerous other types of canvas-protecting compounds on the market. Some of them are no doubt effective, but in general neither treated canvas nor the treating compounds should be purchased without some satisfactory evidence of their merits.

The protective treatment of cloth is much simplified when a dependable ready-mixed compound is available. The initial cost of such treatments, however, is relatively high, and because a good commercial protective compound may not always be readily obtainable, the older formulas given in this circular will often prove useful. They have the advantage of being fairly inexpensive, can be prepared on the farm, and although they do not impart flame resistance to the cloth, can materially extend the outdoor service of fabrics.

Beginning in the summer of 1946 comparative tests of protective treatments were made at New Orleans by exposing to weather for 12 months separate samples of 10-ounce army duck that had been evenly painted on one side with formulas 2 or 4, as given in this circular, along with other samples similarly treated with two commercial canvas-protecting compounds, one of which (A) was of the army type above referred to, and the other (B) was a readily available commercial preparation.

The breaking strength and resistance to water penetration of the freshly treated samples were carefully measured, and the same determinations were repeated after 6 months and 12 months of outdoor exposure. The climatic conditions during the greater part of the test were extremely favorable to the growth of micro-organisms—an untreated duck, for example, was so heavily attacked by mildew that after 6 months it had lost nearly four-fifths (80 percent) of its original breaking strength. In the following tabulation of the observed changes, strength loss is expressed as a percentage of the warp breaking strength in pounds of the unexposed duck; and resistance to water penetration as the hydrostatic pressure, or "head," in inches of a standard water column required to penetrate the fabric.

| | *Strength loss, after exposure* | | *Water resistance (Hydrostatic pressure)* | |
|---|---|---|---|---|
| | *6 months* | *12 months* | *Unexposed* | *Exposed 12 months* |
| Treatment: | *Percent* | *Percent* | *Inches* | *Inches* |
| Untreated control | 77 | 92 | 13 | 5 |
| Formula 4 | 18 | 24 | 35 | 31 |
| Compound (A) | 20 | 21 | 22 | 24 |
| Formula 2 | 33 | 47 | 8 | 9 |
| Compound (B) | 43 | 77 | 17 | 5 |

The extreme severity of the weather conditions that prevailed during the test can be judged by the very high strength loss observed in the untreated control. In comparison, throughout the test the samples finished with formula 4 and commercial compound (A) both showed excellent strength retention and water resistance, compound (A) being slightly superior in the latter quality. Both treatments, however, produced a rather stiff and firm finish when applied to the cloth. The results with formula 2 and compound (B) showed that formula 2 was definitely the superior both in strength retention and water resistance. These two treatments give softer and more flexible samples than the other two.

Although there was considerable variation in the effectiveness of the different treatments, the test showed that all of them would tend to prolong the useful life of exposed cloth.

## WEIGHTS OF COTTON FABRICS

There are frequently slight variations in the weights of duck given in tables 1, 2, and 3. Federal and Army specifications usually state the minimum weights acceptable but permit some leeway to manufacturers in exceeding that minimum. The weights used in these tables conform generally to those given in Commercial Standard CS 28–46 of the United States Department of Commerce.

Table 4 gives the typical constructions of five different kinds of cotton fabrics.

TABLE 1.—*Weights of numbered duck (gray goods, hard texture)*

| No. | Weight per linear yard, basis 22-inch width | Weight per square yard | Ply | |
|---|---|---|---|---|
| | | | Warp | Filling |
| | *Ounces* | *Ounces* | *Number* | *Number* |
| 12 | 7 | 11. 45 | 2 | 2 |
| 11 | 8 | 13. 09 | 3 | 2 |
| 10 | 9 | 14. 73 | 3 | 3 |
| 9 | 10 | 16. 36 | 3 | 3 |
| 8 | 11 | 18. 00 | 3 | 3 |
| 7 | 12 | 19. 64 | 3 | 3 |
| 6 | 13 | 21. 27 | 3 | 3 |
| 5 | 14 | 22. 91 | 3 | 4 |
| 4 | 15 | 24. 55 | 4 | 4 |
| 3 | 16 | 26. 18 | 4 | 5 |
| 2 | 17 | 27. 82 | 5 | 4 |
| 1 | 18 | 29. 45 | 5 | 5 |
| 1/0 | 19 | 31. 09 | 5 | 6 |
| 2/0 | 20 | 32. 72 | 5 | 7 |
| 12/0 | 30 | 49. 09 | 9 | 9 |

TABLE 2.—*Weights of army duck (gray goods)*

| Weight per linear yard, basis 28½-inch width (ounces) | Weight per square yard | Ply | |
|---|---|---|---|
| | | Warp | Filling |
| | *Ounces* | *Number* | *Number* |
| 6 | 7. 58 | 2 | 2 |
| 6.7 (shelter tent) | 8. 43 | 2 | 2 |
| 7 | 8. 84 | 2 | 2 |
| 8 | 10. 11 | 2 | 2 |
| 9 | 11. 37 | 2 | 2 |
| 10 | 12. 63 | 3 | 2 |
| 12 | 15. 16 | 3 | 3 |
| 15 | 18. 95 | 4 | 4 |

TABLE 3.—*Weights of flat duck—single- and double-filled (gray goods)*

| Weight per linear yard, basis 29-inch width (ounces) | Weight per square yard | Weight per linear yard, basis 29-inch width (ounces) | Weight per square yard |
|---|---|---|---|
| | *Ounces* | | *Ounces* |
| 6 | 7. 45 | 10 | 12. 41 |
| 7 | 8. 69 | 11 | 13. 66 |
| 8 | 9. 93 | 12 | 14. 90 |
| 9 | 11. 17 | 15 | 18. 62 |

TABLE 4.—*Miscellaneous cotton fabrics (typical constructions)*

| Common Name | Width | Count | | Weight | |
|---|---|---|---|---|---|
| | | Warp | Filling | Yards to the pound | Ounces to the square yard |
| | *Inches* | | | | |
| Osnaburg | 36 | 40 | 28 | 2. 28 | 7. 0 |
| Coarse sheeting | 40 | 48 | 44 | 2. 50 | 5. 6 |
| Fine sheeting | 36 | 56 | 60 | 4. 00 | 4. 0 |
| Drill | 30 | 72 | 48 | 2. 50 | 7. 5 |
| Tobacco shade cloth | 36 | 28 | 24 | 15. 00 | 1. 1 |

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